



**NIOSH**  
Fire Fighter Fatality Investigation  
and Prevention Program

# Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

November 8, 2000

## **Fire Fighter Collapses at the Fire House and Subsequently Dies due to Heart Arrhythmia Secondary to Myocardial Sarcoidosis - New Jersey**

### **SUMMARY**

On November 16, 1999, a 38-year-old male Fire Fighter awoke at 0100 hours due to severe upper abdominal pain. While being transported to a local hospital, the victim suffered a seizure, followed shortly thereafter by a cardiac arrest in the hospital parking lot. Despite cardiopulmonary resuscitation (CPR) and advanced life support (ALS) administered in the hospital's emergency department, the victim died. An autopsy of the victim revealed an enlarged heart and granulomatous lesions consistent with sarcoidosis in the victim's heart, lung, lymph nodes, liver, and spleen. There was no evidence of coronary artery disease or evidence for a heart attack (myocardial infarction).

Other agencies have proposed a three-pronged strategy for reducing the risk of on-duty sudden cardiac death among fire fighters. However, it is unclear if any of these recommendations would have prevented this Fire Fighter's death. This strategy consists of: 1) minimizing physical stress on fire fighters; 2) screening to identify and subsequently rehabilitate high risk individuals; and 3) encouraging increased individual physical capacity. Issues relevant to this Fire Department (FD) include:

- ***Fire Fighters should have annual medical evaluations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others. The Department and Union should negotiate the content and frequency to be consistent with NFPA 1582.***

***Abnormal findings uncovered during annual medical evaluations should be medically evaluated. If this follow-up medical evaluation is conducted by the fire fighter's personal physician, results should be reviewed by the fire department physician to determine the fire fighter's medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.***

***As required by the OSHA Revised Respiratory Protection Standard, provide fire fighters with medical evaluations to determine fitness to wear a self-contained breathing apparatus (SCBA).***

***Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by phasing in a mandatory wellness/fitness program negotiated between the Fire Department and the Union.***

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at:

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## Fatality Assessment and Control Evaluation Investigative Report #F2000-31

### ***Fire Fighter Collapses at the Fire House and Subsequently Dies due to Heart Arrhythmia Secondary to Myocardial Sarcoidosis - New Jersey***

#### **INTRODUCTION AND METHODS**

On November 11, 1999, a 38-year-old male Fire Fighter experienced the acute onset of severe upper abdominal pain and shortly thereafter died. NIOSH was notified of this fatality on November 30, by the United States Fire Administration. On February 14, 2000, NIOSH contacted the affected Fire Department to initiate the investigation. On June 21, 2000, a physician and an epidemiologist from the NIOSH Fire Fighter Fatality Investigation Team traveled to New Jersey to conduct an onsite investigation of the incident.

During the investigation NIOSH personnel met with and interviewed the

- Chief of the FD;
- Deputy Chiefs of the FD;
- Local President of the International Association of Fire Fighters (IAFF);
- Crew members on-duty at the time of the incident;
- Victim's parents.

During the site-visit NIOSH personnel also reviewed:

- Existing FD investigative records;
- The victim's FD training records;
- The victim's required Hazmat medical evaluations;
- Emergency medical services - ambulance report;
- Hospital emergency department records of the resuscitation effort;
- Death certificate;
- Autopsy;
- FD policies and operating procedures;
- The FD annual run report for 1999.

#### **INVESTIGATIVE RESULTS**

***Incident.*** On November 15, 1999, three fire fighters and their officer began their 24-hour shift at 0800 hours. During the day the crew responded to three

calls (two medical emergencies and one false alarm). At approximately 0100 hours, the crew members were awakened by the victim writhing in pain on the floor, holding his upper abdomen, complaining of "stomach pain." At 0112 hours dispatch received a medical emergency call from the fire house and dispatched an ambulance, which arrived at the 0116 hours. Upon the ambulance's arrival, the victim's pain had subsided, he was conversant, and vital signs were stable. In addition to his abdominal pain, the victim described a mild numbness in both hands.

At 0132 hours the ambulance departed the fire house for the local hospital's emergency department. While en route, at approximately 0134 hours, the victim suffered what was described by emergency medical technicians as a seizure. As the ambulance arrived at the hospital at 0135 hours, the victim was unresponsive, with agonal breathing and no pulse. An oral airway was inserted and he was "bagged" with 100% oxygen as he was rushed into the emergency department. CPR was initiated and ACLS administered by hospital personnel was begun. This included intubation (a breathing tube placed into the victim's windpipe), external defibrillation (shocking the heart using paddles), intravenous administration of medications, and the placement of a temporary pacemaker. After approximately 60 minutes in the emergency department, the victim was pronounced dead at 0230 hours, and resuscitation efforts were discontinued. The victim did not have a history of any previous abdominal or chest pain, nor did he complain of any pain earlier in his shift.

***Medical Findings.*** The death certificate was completed by the medical examiner but the cause of death was deferred until autopsy results were available. Autopsy findings were significant for:

Cardiac hypertrophy and cardiomegaly (a large heart);

No significant atherosclerotic disease of the coronary arteries;



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Sarcoidosis (non-caseating granulomas) of the heart, lung, lymph nodes, liver, and spleen.

The final autopsy report listed “granulomatous myocarditis due to sarcoidosis, generalized” as the cause of death.

Review of the victim’s medical records indicated that at the FD’s pre-employment medical evaluation seven years previously the victim had a normal chest X-ray (CXR), normal lung function (spirometry), and some abnormalities on electrocardiogram (EKG) (left ventricle hypertrophy by voltage, peaked T waves in leads V-2 and V-3, and up-sloping ST segment elevation in V-3-V-6). These EKG abnormalities were interpreted as consistent with an “athletic heart” in a fit, asymptomatic 31-year-old-man. In 1996, the victim had periodic FD medical evaluation as required for HAZMAT duty. This medical evaluation reported similar CXR, lung function [pulmonary function tests (PFTs)], and EKG findings. However, in 1998, the victim’s HAZMAT medical evaluation showed several changes. His CXR suggested enlarged right paratracheal and right bronchopulmonary lymph nodes. His PFTs were still within “normal” range, but a significant was noted from his previous test in 1996. His EKG was unchanged. The examining physician cleared him for duty, but noted he needed close follow-up of these changes, specifically a chest “CAT” scan with his private physician. There is no evidence at this time of this investigation that the victim sought further medical evaluation after this evaluation.

#### **DESCRIPTION OF THE FIRE DEPARTMENT**

At the time of the NIOSH investigation, the fire department was comprised of 590 uniformed personnel and served a population of 232,000 residents, in a geographic area of 21 square miles. There are 16 fire stations where fire fighters work

the following tour of duty: 24 hours on, 72 hours off. Each shift of an engine company is staffed with an officer and three fire fighters. Each shift of a ladder company is staffed with an officer and three fire fighters. Throughout the day, the victim did not report or show any signs of discomfort, pain, or distress. The victim went on three responses, two medical calls and one false alarm call that shift.

In 1999, the department responded to 18,840 total calls: 8922 emergency medical calls, 822 hazardous materials calls, 1,025 structure fires, 958 non-structural fires, 3997 unclassified calls, and 3,116 false alarms. The emergency medical service is operated by private companies.

Training. The fire department provides all new fire fighters with the basic 8-week training to become certified to the National Fire Protection Association (NFPA) Fire Fighter II level. All are State-certified First Responders and are certified in CPR, defibrillator, and hazardous materials operations. The department also conducts monthly training. The victim had seven years of fire fighting experience and was a NFPA-certified Fire Fighter II and a HAZMAT technician.

Pre-employment/Pre-placement Evaluations. The department requires a pre-employment/pre-placement medical evaluation for all new hires, regardless of age. Components of this evaluation for all applicants include:

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Blood Tests: Complete blood count (CBC), SMA 6, and liver function tests
- Urinalysis for sugar and kidney function
- Chest X-ray
- Electrocardiogram (EKG)
- Exercise electrocardiogram.
- Pulmonary function test

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- Test for syphilis
- Two step PPD (Tuberculin test)

These evaluations are performed by a City contract physician, who makes a decision regarding medical clearance for fire fighting duties. The results of the medical examination are kept confidential by the contract physician and only the clearance status is reported to the County Fire Department. New hires are also required to complete a physical agility test. This is a timed performance evaluation of typical fire fighting duties.

*Periodic Evaluations*

Other than for HAZMAT responders, annual medical evaluations are optional for Fire Fighters. Components of this “optional” evaluation include:

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Blood Tests: Complete blood count (CBC), SMA 6, and liver function tests
- Urinalysis for sugar and kidney function
- Chest X-ray
- Electrocardiogram (EKG)
- Exercise electrocardiogram.
- Pulmonary function test
- Test for syphilis
- Two step PPD (Tuberculin test)

These evaluations are also performed by the City contract physician who makes a decision regarding medical clearance for fire fighting duties. The FD estimated that approximately 5% of the fire fighters participate in this voluntary medical evaluation program. If an employee is injured at work, he/she must be cleared for “return to work” by the City contract physician. If an employee has been on sick leave for more than 3 consecutive calendar days, he/she must also be cleared for “return to work” by the City contract physician if the illness was work related or by their personal physician if the illness

was of a non-work related nature. Most stations have exercise (strength and aerobic) equipment, purchased by the fire fighters, but there is no fitness program in place.

**DISCUSSION**

Sarcoidosis is a chronic, multisystem disorder of unknown etiology (cause). It is characterized by the accumulation of inflammatory cells (T-helper lymphocytes and mononuclear phagocytes), followed by the formation of “noncaseating epithelioid granulomas,” (a term used by pathologists to describe the microscopic lesions), which can disrupt the normal tissue structure and function. The lung and lymph nodes are most commonly involved, but other organs can be affected including the skin, eyes, and heart. The clinical course of the disease is variable, ranging from acute onset, typically involving respiratory symptoms, to a chronic disease with symptoms that wax and wane over many years. As in the case of this fire fighter, some cases are completely asymptomatic and are only identified by chest X-ray.<sup>1</sup>

The characteristic histologic (microscope) lesions are typically found on lung biopsy. Although the histologic findings are required for a definitive diagnosis, noncaseating granulomas are not specific to sarcoidosis and are found in a number of other diseases, including infections and malignancies. Thus, the diagnosis of sarcoidosis is made by a combination of clinical, radiographic (X-rays), and histologic (microscope) findings.<sup>1</sup>

The incidence and prevalence of sarcoidosis in the United States vary by race, gender, and age.<sup>2-8</sup> The study which best adjusted for these demographic variables was published by Rybicki et al. in 1997.<sup>2</sup> They conducted a longitudinal cohort study of newly diagnosed cases between 1990 and 1994 among members of a health maintenance organization in



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Detroit, Michigan. They found the following demographic variables as being independent risk factors for sarcoidosis:

- African-American race [relative risk (RR)=3.8];
- Female gender (RR=1.3);
- Ages 30-39 years (RR=1.7);
- Ages 40-49 years (RR=1.4)

As mentioned earlier, the cause of sarcoidosis is unknown, but environmental, infectious, and genetic risk factors has been hypothesized as etiologic agents. Fire fighters have been reported to have relatively high rates (discussed below), presumably due to their exposure to a variety of toxins in smoke or exposure to communicable diseases while performing their duties as first responders.<sup>3,9</sup> The first report, published by Kern et. al. in 1993, investigated a cluster of three cases of sarcoidosis among ten white fire fighters who trained together as apprentices in 1979.<sup>9</sup> A subsequent case finding questionnaire survey of 1,282 active and retired male fire fighters and police officers, followed by a medical evaluation, found one additional case for an overall point prevalence of 312 per 100,000. This point prevalence is higher than the general population point prevalence of 17 per 100,000 for whites and 64 per 100,000 in blacks collected 30 years earlier.<sup>8</sup>

Prezant and colleagues conducted a longitudinal cohort study of newly diagnosed cases between 1985 and 1998 among New York City (NYC) fire fighters.<sup>3</sup> Using chest X-rays taken during periodic wellness medical evaluations and requiring cases to be biopsy-proven, Prezant et al. found an annual incident rate of 12.9 cases per 100,000 among white fire fighters. This rate is higher than the incident rate of age-adjusted biopsy proven cases of sarcoidosis in white males (5.9 per 100,000 per year) or of age-adjusted biopsy and clinical cases of sarcoidosis in white males (9.6 per 100,000 per year).<sup>2</sup> Unfortunately, this finding could be due to the following differences between the two studies: case

ascertainment (active versus passive), case definitions (biopsy versus clinical), and age distributions (not age-adjusted versus age-adjusted). Looking specifically at the age distribution, Rybicki et al. found the incidence rates among white males to be highest among the 40-49 years old group (24 per 100,000 per year), followed by the 30-39 year old group (22 per 100,000 per years) and the 20-29 year old group (12 per 100,000 per year).<sup>2</sup> Using these age specific rates as the comparison group (typical ages of active duty fire fighters), the incident rates of NYC fire fighters do not appear elevated.

Among patients diagnosed with sarcoidosis, granulomatous lesions in the heart have been found in approximately 15% of patients.<sup>10-12</sup> Cardiac involvement is clinically recognized in about 5% of known sarcoid patients, and subclinical (identified at autopsy) in the other 10%. Both groups are at increased risk of sudden death, conduction abnormalities (bundle branch blocks, partial and complete heart block), arrhythmias (ventricular and supraventricular), and congestive cardiomyopathy.<sup>10-19</sup> In fact, as in the case of this fire fighter, sudden cardiac death is the most common first manifestation of cardiac sarcoidosis.<sup>12-15</sup> The victim's acute onset of upper abdominal pain has not been reported as a presentation of sarcoidosis. Most likely, this pain was cardiac in origin, probably secondary to some type of arrhythmia.

To ensure that candidates and current fire fighters are medically capable of performing their required tasks and to reduce the risk of occupational injuries and illnesses, the National Fire Protection Association (NFPA) has developed guidelines entitled "Medical Requirements for Fire Fighters and Information for Fire Department Physicians," otherwise known as NFPA 1582.<sup>20</sup> These guidelines, updated in 2000, specifies minimum medical requirements for candidates and current fire fighters. Although sarcoidosis is not specifically mentioned, the guideline

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does address the effect sarcoidosis can have on the various organs (e.g. lungs, heart). For example, the victim had left ventricular (heart) hypertrophy diagnosed by EKG. NFPA 1582 considers hypertrophy of the heart (enlarged heart) a Category B Medical Condition is defined as “a medical condition that, based on its severity or degree, could (our emphasis) preclude a person from performing as a fire fighter in a training or emergency operational environment by presenting a significant risk to the safety and health of the person or others.” Given the victim’s fitness level, lack of symptoms, and low normal PFTs, the decision to clear the victim for fire fighting duties in 1998 was consistent with NFPA guidelines. The recommendation that the victim seek further evaluation of his abnormal CXR, EKG, and recent drop in his lung function with his private physician is also consistent with NFPA guidelines and standard medical care. However, the Fire Department physician should have followed up the case to ensure that the fire fighter was subsequently evaluated, and to review the subsequent tests. With this information, the Fire Department physician could have updated the fire fighter’s medical clearance for full duty.

Annual medical evaluations are also recommended by NFPA 1582 and the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.<sup>21</sup> Perhaps, if this FD required annual medical evaluations, and the FD physician re-emphasized the need to for follow-up, the victim may have sought further medical evaluation by his personal physician. This would probably have led to a transbronchial biopsy, a diagnosed of sarcoidosis, and probably treatment with corticosteroids. This may have prevented his sudden cardiac death.

## **RECOMMENDATIONS AND DISCUSSION**

The following recommendations address health and safety generally. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of sudden cardiac arrest and or death among fire fighters. However, it is unclear if any of these recommendations would have prevented this Fire Fighter’s death. In addition, these recommendations have not been evaluated by NIOSH, but represent research presented in the literature or of consensus votes of Technical Committees of the National Fire Protection Association or labor/management groups within the fire service. This strategy consists of: 1) minimizing physical stress on fire fighters; 2) screening to identify and subsequently rehabilitate high risk individuals; and 3) encouraging increased individual physical capacity. Issues relevant to this Fire Department (FD) include:

***Recommendation #1: Fire Fighters should have annual medical evaluations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others. The Department and Union should negotiate the content and frequency to be consistent with NFPA 1582.***

Guidance regarding the content and frequency of periodic medical evaluations for fire fighters can be found in NFPA 1582, Medical Requirements for Fire Fighters<sup>20</sup> and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs (IAFF/IAFC) wellness/fitness initiative.<sup>21</sup>

Applying the above NFPA standard involves legal and economic repercussions and must be carried out in a nondiscriminatory manner. Appendix D of NFPA 1582 provides guidance for Fire Department



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Administrators regarding legal considerations in applying the standard.

Economic repercussions go beyond the costs of administering the medical program. Department administrators, unions, and fire fighters must also deal with the personal and economic costs of the medical testing results. NFPA 1500 addresses these issues in Chapter 8-7.1 and 8-7.2.<sup>22</sup> The success of medical programs may hinge on protecting the affected fire fighter. The department should provide alternate duty positions for fire fighters in rehabilitation programs, if possible. If the fire fighter is not medically qualified to return to duty after repeat testing, supportive and/or compensated alternatives for the fire fighter should be pursued by the Department. Other than for the statement regarding duty status, these medical records should be kept confidential.

***Recommendation #2: Abnormal findings uncovered during annual medical evaluations should be medically evaluated. If this follow-up medical evaluation is conducted by the fire fighter's personal physician, results should be reviewed by the fire department physician to determine the fire fighter's medical ability to perform duties without presenting a significant risk to the safety and health of himself or others.***

NFPA 1582 requires all evaluations completed by outside physicians be reviewed and approved by the Fire Department physician (Chapter 2-2.5.1 and Chapter 2-4.1.1).<sup>20</sup>

***Recommendation #3: As required by the OSHA Revised Respiratory Protection Standard, provide fire fighters with medical evaluations to determine fitness to wear a self-contained breathing apparatus (SCBA).***

OSHA's Revised Respiratory Protection Standard requires employers to provide medical evaluations

and clearance for employees using respiratory protection.<sup>23</sup> These clearance evaluations are required for private industry employees and public employees in States operating OSHA-approved State plans. Since New Jersey is a State-plan State, public sector employers are required to comply with OSHA standards. A copy of the OSHA medical checklist has been provided to the Fire Department and should not involve a financial burden to the Fire Department beyond that required for the fitness-for-duty medical evaluation.

***Recommendation #4: Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by phasing in a mandatory wellness/fitness program negotiated between the Fire Department and the Union.***

NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.<sup>22</sup> In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) joined in a comprehensive Fire Service Joint Labor Management Wellness/Fitness Initiative to improve fire fighter quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual and a video detailing elements of such a program.<sup>21</sup> The Fire Department should review these materials to identify applicable elements. Other large-city negotiated programs can also be reviewed as potential models.

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**INVESTIGATOR INFORMATION**

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